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CONCISE COMMUNICATION

Extended-Spectrum β-Lactamase (ESBL)–Producing Enterobacteriaceae: A Threat from the Kitchen

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Food is an established source of extended-spectrum β-lactamase (ESBL)–producing Enterobacteriaceae. Hand hygiene and cooking prevent transmission, but hands could be recontaminated by touching used cutting boards. ESBL-producing *Escherichia coli* were identified on 12% of cutting boards and 50% of gloves after poultry preparation, pointing to an important source for transmission.

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INTRODUCTION

The epidemiology of healthcare-associated infections has been characterized by the emergence of gram-negative multidrug-resistant organisms, including extended-spectrum β-lactamase (ESBL)–producing Enterobacteriaceae, during the past decade. While nosocomial transmission was initially considered their principal cause of spread, recent reports point to the importance of the food chain as a continuous source of dissemination,[1] explaining in part the expansion of such organisms to community settings.[2] In addition to a growing body of literature regarding the detection of ESBL-producing Enterobacteriaceae in retail meat and food animals worldwide, food has been reported as a transmission vector for ESBL-producing *Klebsiella pneumoniae* in a hospital outbreak,[3] leading to the conclusion that infection control teams should consider extending their surveillance to kitchen facilities and foodstuffs. We aimed to explore potential transmission pathways explaining the spread of ESBL-producing Enterobacteriaceae from the food chain to humans in both hospital and community settings, by examining cutting boards and gloves after use for food preparation.

METHODS

The University Hospital Basel is a tertiary care center in Switzerland admitting more than 32,000 adult patients yearly. Its kitchen prepares meals for approximately 650 patients daily and for the hospital staff. The study was approved by the local ethics committee as part of the quality assurance program.

From December 2011 to May 2012, cutting boards used in the kitchen of the University Hospital were examined for the presence of ESBL-producing Enterobacteriaceae after food preparation and before being cleaned, as were gloves of the kitchen personnel after they handled raw poultry. In addition, cutting boards from private households in different countries (Switzerland, France, and Germany) were swabbed after being used for preparation of food during the same time period (and before being cleaned). Information regarding origin of food was collected. Gloves of kitchen employees were latex-free vinyl gloves (Nitrile Examination Gloves, powder free, AQL [acceptable quality level] 1.5, En MediPart). They were randomly chosen on different days across the study period.

A standardized area (48 cm^2) of each cutting board was swabbed with a sterile cotton swab premoistened with enrichment broth (trypticase soy broth, bioMérieux). Samples were then cultured in enrichment broth supplemented with 0.5% sodium chloride for at least 18 hours.[4] Subsequently, an aliquot of the broth was subcultured onto a chromogenic ESBL-screening agar plate (chromID ESBL, bioMérieux) incubated for at least 18 hours.

Gloves were turned inside out after use and placed in a sterile plastic bag. They were filled with supplemented enrichment broth and cultured for at least 5 hours at 36°C. After membrane filtration of 10–30 mL of the enrichment broth, the filter was placed onto a selective chromogenic medium (chromID ESBL) and incubated for at least 18 hours.

The presence of bla_{ESBL} genes belonging to the TEM, SHV, or group 1, 2, or 9 CTX-M families of β-lactamases was confirmed by polymerase chain reaction using primers and conditions as reported elsewhere.[5] The exact types of the detected ESBLs were determined through sequencing of the entire open reading frames of the respective bla_{ESBL} genes.[6]

The Fisher exact test was used for comparisons of proportions. Two-sided P values of <0.05 were considered significant. Analyses were performed with STATA statistical software, version 12.0 (Stata).

RESULTS

Overall, 298 cutting boards were sampled: 154 from the hospital and 144 from different sites in the community. Of the cutting boards from the hospital kitchen, 6.5% (10/154) were positive for ESBL-producing *Escherichia coli*, the vast majority carrying genes encoding for CTX-M group β-lactamases (90%, 9/10). No ESBL-producing enterobacterial species other than *E. coli* were detected. All ESBL-positive samples derived from cutting boards swabbed after being used to process poultry; none were found after processing of other kinds of meat (Table 1). Overall, 57.3% (71/124) of the meat processed on sampled cutting boards originated from Swiss producers. Contamination of the meat did not differ between countries of origin (Table 2).

Twenty pairs of gloves worn by kitchen personnel were examined after handling of raw poultry for presence of ESBL producers, which were detected in 50% of the pairs (10/20).

TABLE 1. Detection of ESBL-Producing Enterobacteriaceae from Cutting Boards and Gloves after Preparation of Different Foods

	n	Detections of ESBL-producing Enterobacteriaceae (%)	Detections of ESBL-producing *Escherichia coli*		
			CTX-M-1 (%)	CTX-M-14 (%)	SHV-12 (%)
Cutting boards from the hospital kitchen after handling	154				
Poultry	64	10 (15.6)	8 (12.5)[a]	1 (1.6)	1 (1.6)
Beef/veal	31	0 (0.0)	0	0	0
Pork	15	0 (0.0)	0	0	0
Lamb	4	0 (0.0)	0	0	0
Game	8	0 (0.0)	0	0	0
Fish	2	0 (0.0)	0	0	0
Vegetables	30	0 (0.0)	0	0	0
Gloves after handling poultry	20	10 (50)	6 (30)	0	4 (20)
Cutting boards from private households after handling	144				
Poultry	62	5 (8.1)	2 (3.2)[a]	0	3 (4.8)
Beef/veal	53	0 (0.0)	0	0	0
Pork	17	0 (0.0)	0	0	0
Lamb	8	0 (0.0)	0	0	0
Game	4	0 (0.0)	0	0	0

NOTE. Data are no. of detections (% of *n*). ESBL, extended-spectrum β-lactamase.

[a] One each of the ESBL-*Escherichia coli* strains expressing CTX-M-1 among the marked sets harbored an additional bla_{TEM} gene specifying the classical broad-spectrum β-lactamase TEM-1.

Again, no Enterobacteriaceae other than *E. coli* were recovered, and the majority of genes comprised CTX-M group enzymes (60%, 6/10), followed by SHV-12 enzymes (40%, 4/10; Table 1).

In addition, we sampled 144 cutting boards from private households to extend validity of our data generated from the hospital. ESBL-producing *E. coli* was recovered from 5 samples (3.5%), all after processing of poultry. CTX-M determinants were identified in 2 samples and SHV-12 in the remaining 3 (Table 1). Again, the origin of the meat was not associated with the presence of ESBL producers (Table 2).

DISCUSSION

ESBL-producing *E. coli* was commonly recovered from cutting boards and gloves after use for raw poultry reprocessing, reflecting reports on detection of CTX-M-1 ESBLs in up to 78% of chicken meat.[7,8] None of the cutting boards used for raw meat other than poultry tested positive, mirrored by the absence of ESBL-producing strains in minced meat derived from pork and cattle.[6] Our study provides evidence that kitchen equipment and hands can easily become contaminated with ESBL-producing *E. coli* after processing of raw poultry, revealing an important potential source for ongoing transmission in both hospital kitchens and private household settings. These findings emphasize hand hygiene not only after handling raw poultry but also after contact with cutting boards used for poultry preparation. The importance of our results is underscored by a study reporting significant genetic similarities among ESBL-producing *E. coli* isolates from chicken meat and humans according to mobile resistance elements, virulence genes, and genomic backbone,[1] strongly supporting a link between ESBL-producing *E. coli* from chicken meat and humans.

In a recent report on a food-borne nosocomial outbreak due to ESBL-producing *K. pneumoniae*, up to 35% of the screened hospital kitchen surfaces or foodstuffs were found to be contaminated, and in addition, 14% of food handlers were revealed as rectal carriers.[3] Among foodstuffs, only handmade fruit puree was found to be contaminated. We speculate that food handlers regularly perform hand hygiene after handling meat. However, it is likely that they fail to do so after touching cutting boards, resulting in colonization and further transmission of ESBL producers. Despite this report, we believe that contaminated cutting boards and hands after processing of raw meat mainly account for transmission in community settings, supporting reports on high transmission rates in household settings.[9]

Several limitations of our study should be mentioned. We did not aim to assess the possibility of transmission from cutting boards to the staff of the kitchen or patients. However, contamination of hands is almost equally likely after contact with colonized skin and after contact with contaminated surfaces.[10] The kitchen of only one hospital was assessed, possibly limiting generalizability to other settings. However, we tested cutting boards from private households in three different European countries, supporting our results generated from the hospital. We cannot rule out that the higher percentage of ESBL detection on cutting boards from the hospital kitchen

TABLE 2. Distribution of ESBL-Producing *Escherichia coli* by Country of Origin

	n	Detections of ESBL-producing Enterobacteriaceae (%)	*P* value[a]
Cutting boards from the hospital kitchen after handling meats from[b]	105		.422
Switzerland	71	5 (7.0)	
France	18	4 (22.2)	
Hungary	11	1 (9.1)	
Ireland	2	0 (0.0)	
New Zealand	2	0 (0.0)	
The Netherlands	1	0 (0.0)	
Cutting boards from private households after handling meats from[c]	142		.207
Switzerland	104	3 (2.9)	
Germany	18	0 (0.0)	
France	5	1 (20.0)	
Slovenia	4	1 (25.0)	
Austria	3	0 (0.0)	
Ireland	2	0 (0.0)	
New Zealand	2	0 (0.0)	
Australia	1	0 (0.0)	
Great Britain	1	0 (0.0)	
Hungary	1	0 (0.0)	
Spain	1	0 (0.0)	

NOTE. ESBL, extended-spectrum β-lactamase.

[a] Overall comparison for each category (Fisher exact test).

[b] The country of origin was known for 84.7% (105/124) of meats processed in the hospital kitchen.

[c] The country of origin was known for 98.6% (142/144) of meats processed in private households.

was due to more standardized collection of swabs by only one person, in contrast to samples obtained in private households.

In conclusion, cutting boards and hands can easily become contaminated with ESBL-producing *E. coli* after processing of raw poultry meat, revealing an important potential source for ongoing transmission in both hospital and private household settings. Hand hygiene recommendations should be extended to performance not only after touching raw poultry but also after touching used cutting boards.

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